

## New Apparatus for Measuring the Scuff Resistance of Leather\*

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### *Introduction*

The scuff resistance of light leathers is an important physical property in appraising their quality. Various types of equipment have been used for measuring this property, some of which have been considered by the American Leather Chemists Association for adoption as standard. Among these is a machine developed by M. Maeser.<sup>1</sup> Studies with this machine, however, brought out some points which appeared to need improvement or modification.

An apparatus devised in this laboratory for measuring the scuff resistance of leather is simple and easily applied and is believed to give more satisfactory results than other methods tested. It consists of parts to be mounted on the Tinius Olsen Stiffness Tester, 5 Inch-Pound Capacity<sup>2</sup>—now used as the A.L.C.A. standard machine for measuring flexibility of leather.

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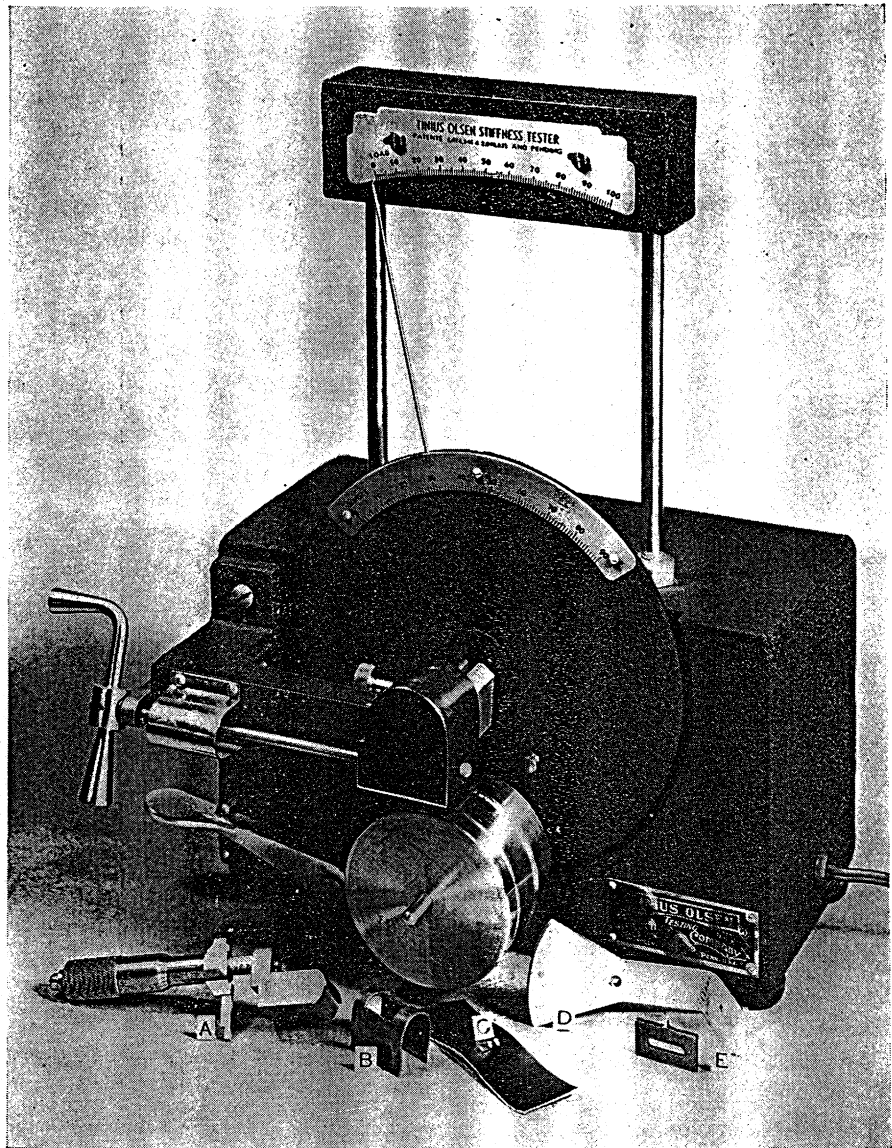


FIGURE 1. Apparatus for measuring the scuff resistance of leather. A, adjustable work support; B, clamp; C, leather specimen; D, lever arm; E, scuffing blade.

## *Apparatus*

The new apparatus,<sup>†</sup> shown in Figure 1, consists of an adjustable work support, A, mounted on the spindle of an inside micrometer, a clamp, B, for holding the specimen, C, in position, a lever arm, D, to which is attached the scuffing blade, E. In assembling the apparatus, the lever arm D is attached to the face of the stiffness tester in the 2-inch-span position. The work support A is held firmly by the clamp on the machine with the rounded end parallel with the bent end of the lever arm D. The scuffing blade is fastened in position as shown in Figure 2, and the machine loaded to full capacity of 5 inch-pounds.

## *Testing Procedure*

The size of the leather specimen should be approximately 1 by 2 inches. Rotate the work support in a counterclockwise direction, by means of the crank, until the clamp screw just touches the load weights. Place the specimen, grain side up, over the work support and fasten it firmly in place with the clamp B. Rotate the work support until the opening in clamp B is opposite the scuffing blade E, then adjust the work support by means of the micrometer until the specimen nearly touches the tip of the scuffing blade. Again rotate the work support until the distance between the specimen and the tip of the scuffing blade is at the minimum; then make the final adjustment of the micrometer so that the specimen just touches the blade. Since the precision of measurements depends to a large extent upon this adjustment, parallax should be avoided. A reading glass may be used to advantage in making the final adjustment.

Raise the work support by one turn of the crank and adjust the specimen by means of the micrometer so as to produce the desired depth of scuff, 0.010 to 0.025 inch. Complete the test by pressing the motor-control lever and note the maximum percentage load indicated before the blade scuffs through the specimen.

Without removing the specimen, turn the micrometer until the specimen clears the scuffing blade, then rotate the work support to a point opposite the scuffer blade. Adjust the scuffing blade to a new position approximately three-sixteenths inch from the edge of the scuff and repeat the scuffing procedure at this position. Two or three scuffs may be made without removing the specimen. This testing procedure is similar to the static method<sup>1</sup> used on the Maeser machine.

All tests reported in this paper were conducted on specimens conditioned and tested at 70° F. and 65 per cent relative humidity.

<sup>†</sup> Drawings and specifications may be obtained from this laboratory on request.



FIGURE 2. Scuffing apparatus assembled ready for use.

### *Experimental Comparisons*

The first experiment with the new apparatus was designed to compare its performance with that of the Maeser machine. As the object of the test was to compare the performance of the machines and not to compare leathers, no attempt was made to obtain representative or comparable samples of leather. Instead each 1 by 6 inch piece was tested on both machines in order to minimize sampling errors. Thus the measurements by the two machines were comparable, although the averages may not give a good estimate of the relative scuff resistance of the leathers represented. Since preliminary tests had shown that a single depth of scuff was not satisfactory for testing all leathers, the two arbitrary depths, 0.010 and 0.015 inch, were used in order to increase the number of comparable measurements.

The results in Table I show that: (1) the relative ratings of the leathers are approximately the same by the two machines; (2) the load required to scuff by the new machine is much greater than that of the Maeser machine; for example, at 0.010 inch depth, the kangaroo leather required a load of 0.63 pound ( $28 \times 0.0225$ ) on the Maeser machine and 2.2 pounds ( $0.74 \times 3.0$ ) on the new machine; (3) the new machine produces a much greater proportion of satisfactory scuffs than the Maeser machine; that is, fewer trials resulted in "scraping scuffs," in which the scuffing blade makes a depression in the leather and scrapes along the surface without cutting into the leather; and (4) the scuff resistance depends upon the direction of scuffing.

Although the shark leather in this experiment was not scuffed by either machine, another sample has since been tested on the new apparatus and found to have about the same scuff resistance as the kangaroo leather reported here.

The difference in scuffing load is probably due to a difference in the method of fastening specimens on the machines. On the Maeser machine, the specimen is attached at a distance of 4 inches from the scuffing area. This distance allows the leather to stretch during the test, and as the specimen stretches the scuffing blade moves forward through an arc without cutting. The length and depth of the cut, therefore, are less than they would have been if the specimen had not stretched. On the new apparatus, stretching is eliminated by clamping the specimen within one-quarter inch of the scuffing area. Therefore, the scuffing load is greater than on the Maeser machine.

The loading capacity of the Maeser machine is 36 inches of chain, but with this load many of the pieces could not be scuffed by the regular procedure. In order to increase the number of comparable measurements, the capacity was increased by attaching weights to the loading chain and adding the equivalent to the load. It was possible to obtain 29 additional measurements by this procedure, although the change in procedure is probably reflected in the results.

TABLE I  
RESULTS OF SCUFF TESTS ON MAESER'S MACHINE AND THE NEW MACHINE

Kind of Leather	Piece No.	Direction of Scuff†	MAESER'S MACHINE (Load—Inches of Chain)*		NEW MACHINE Load Required to Produce Scuff†	
			Inches		Per Cent	
			0.010 inch	Depth of Scuff— 0.015 inch	0.010 inch	Depth of Scuff— 0.015 inch
Kangarooskin.....	1	A	48, 54, 49	52§	82, 94, 71, 88.	.....
		B	35, 48, 40	.....	65, 76, 73	.....
	2	A	19, 15, 9	.....	34, 30, 30#	103, 108
		B	15, 20, 14	.....	47, 27#, 34#	77, 80
	3	A	10, 27, 21	61	78, 88	.....
		B	44, 52§	70§	93, 82, 80	.....
	4	A	23, 21	52	67, 62	110§
		B	14#, 14#	49, 52§	58, 43#, 43#, 58	103, 86
	Average		28	.....	74	.....
Goatskin, India.....	1	A	20, 12#, 22	32, 35	60, 62	96, 106, 91, 92
		B	20, 25	42	66, 64	95, 89
	2	A	16, 9#, 9#	36, 38	60, 56	95, 95
		B	24, 29, 26	49, 50	51, 65, 53	97
	Average		23	40	60	95
Goatskin, India, resin treated.....	1	A	24, 28	33, 41	62, 62	88, 92
		B	32, 32	56	69, 64, 72	95, 100
	2	A	28, 31	52	62, 65	91
		B	33, 32	45	64, 54	90, 92
	Average		30	45	64	92
Goatskin, Brazil.....	1	A	8#, 7#	40, 46	46, 54, 51	94, 85, 108, 98
		B	9#	33, 18#, 28, 28	50, 60, 53	88, 85, 88
	2	A	7#, 6#	23, 29	34, 69, 27#, 54, 28#, 56	89, 83, 77
		B	5#	36, 33	64, 42, 46, 58, 55	92
	3	A	5#	34, 35	46, 49	86, 90, 87
		B	7#	31, 29	51, 45	88, 76, 86
	Average		33	33	52	88

TABLE I (Continued)

## NEW MACHINE

## MAESER'S MACHINE

Load Required to Produce Scuff

(Load—Inches of Chain)\*

Kind of Leather	Piece No.	Direction of Scuff†	Depth of Scuff		Depth of Scuff	
			0.010 inch	0.015 inch	0.010 inch	0.015 inch
			Inches	Inches	Per Cent	Per Cent
Calfskin, chrome.....	1	A	16#, 12#, 20	34, 38	48, 43, 42, 49, 51, 53	82, 77
		B	23, 25	46, 52	57, 57, 56, 60, 58	82, 83
	2	A	7#, 7#	30, 31	48, 55, 59, 60	73, 70, 71, 74, 73
		B	9#	30, 33	45, 50, 43, 43	74, 73, 62, 66
Alligatorskin.....	Average		.....	37	51	74
			26, 18, 17	52, 43	35, 43, 42	82, 90, 86
	1	A	32, 13, 14	51	60, 38, 22#, 36, 31, 61, 58	72, 55, 50, 77
		B	10#, 7#	31, 16#, 27	39, 54, 33#, 40	64, 70, 64, 82, 80, 82, 60, 60
Chrome, side upper.....	2	A	10#, 9#	34, 20, 34	34, 33, 32	70, 86, 79, 51#, 50#, 81
		B				
	Average		.....	36	42	73
			7#, 11#	22, 24	44, 41, 24#	66, 56, 57, 61
Sheepskin, sumac skiver.....	1	A	14#, 15#	25, 26	28#, 50, 34#, 41#	82, 94, 106, 83, 96
		B				
	Average		.....	24	.....	78
			3#	7#, 8#	4#	36, 42, 36
Sharkskin.....	1	B	3#	6#	15#, 11#	55, 48, 50
			.....	.....	.....	44
	Average		.....	.....	.....	71#
			8#	24#	41#	60#
Average		6#	19#	35#	.....	

\*One inch of chain weighs 0.0225 pound.

†Load is recorded as per cent of 3.0 pounds.

‡Each piece was scuffed in two opposite directions A and B.

§Sample did not scuff.

#Leather surface was scraped, but no V shaped scuff was produced.

TABLE II  
SCUFF RESISTANCE OF COATED AND OF UNCOATED LEATHERS

Kind of Leather	Piece No.	Direction of Scuff†	Load Required to Produce Scuff*		Average	
			At Depth of 0.015 inch	At Depth of 0.025 inch	At Depth of 0.015 inch	At Depth of 0.025 inch
			Per Cent	Per Cent	Per Cent	Per Cent
Cabretta, coated	1	in	9‡	.....	60, 57, 60	59 60
		out	.....	.....	59, 63, 64	62 60
	2	in	.....	.....	62, 58, 55	58 58
		out	.....	.....	52, 56, 63	57 58
Cabretta, uncoated	1	in	15‡	.....	60, 58, 59	59 54
		out	.....	.....	52, 50, 48	50 54
	2	in	.....	.....	52, 50, 45	49 56
		out	.....	.....	63, 67, 63	64 56
Horsehide, coated	1	in	31, 33, 30	31 25	78, 93, 106	92 78
		out	22, 15, 20	19 20	64, 65, 61	63 78
	2	in	22, 15, 22	20 20	82, 90, 78	83 76
		out	17, 22, 21	20 20	69, 68, 66	68 76
Horsehide, uncoated	1	in	13, 21, 30	21 18	87, 68, 62, 90	77 70
		out	18, 13, 13	15 18	73, 59, 55	62 70
	2	in	15, 13, 11	13 12	46, 49, 57	51 50
		out	12, 11, 12	12 12	47, 50, 47	48 50
Sheepskin, coated	1	in	41, 35, 32	36 30	.....	.....
		out	24, 23, 21	23 30	.....	.....
	2	in	46, 58, 51	52 40	.....	.....
		out	29, 28, 27	28 40	.....	.....
Sheepskin, uncoated	1	in	31, 24, 21	25 25	.....	.....
		out	29, 22, 24	25 25	.....	.....
	2	in	33, 47, 31, 40	38 30	.....	.....
		out	21, 26, 22	23 30	.....	.....

†Direction leading "into" hair follicle or "out" of hair follicle.  
‡Leather surface was scraped, but no V-shaped scuff was produced.  
\*Load is recorded as per cent of 3.0 pounds.

The results show that of 128 trials on the Maeser machine (omitting the shark leather), 33 resulted in scraping scuffs and 29 exceeded the capacity of the machine, whereas on the new machine 197 trials resulted in 19 scraping scuffs and one failure to scuff within the capacity of the machine. Thus the proportion of satisfactory trials was 52 per cent (66/128) with the Maeser machine and 90 per cent (177/197) with the new machine.

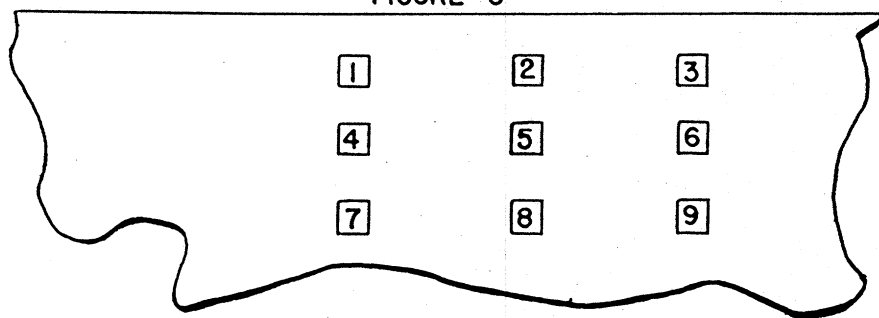
The directional variation in scuff resistance is perhaps due to the variation in fiber structure in different directions. Indications are that scuff resistance is greater in the direction leading into the hair follicles than in the opposite direction.

Other advantages of the new machine are the shorter time and less work required for a test. The testing time per trial with the new machine is approximately one-third that of the Maeser machine. And since the new machine is driven by electricity, there is a great saving in work by the operator.

One possible application of a scuff-testing machine is in measuring the effect of finishing operations on the scuff-resistance of leather. In order to obtain some information on this problem, three samples of leather finished with a coating material were compared with similar uncoated leather. The leathers were scuffed in the direction leading into the hair follicles and in the opposite direction. This furnished more data on the directional variation in scuff resistance and at the same time gave a better measurement of the scuff resistance of each specimen.

The results in Table II indicate that the coated leathers are slightly more resistant to scuffing than the uncoated leathers, although the difference, based upon this small number of tests, is not significant. The average scuffing load was greater in the direction leading into the hair follicles in 12 trials and greater in the opposite direction in only 2 trials. In 2 trials it was the same.

FIGURE 3



SAMPLING POSITIONS ON A CALFSKIN

TABLE III  
SCUFF RESISTANCE OF LEATHER PER UNIT WIDTH OF SCUFF

Kind of Leather	Direction	Depth of Scuff	Load Required to Produce Scuff*	Maximum Width of Scuff	Load Divided by Width	Average
		0.001 in.	Per Cent	mm.		
Side upper.....	A	10	53, 53, 46	1.2, 1.0, 1.0	44, 53, 46	48
	B (opposite A)	10	51, 43, 40	1.3, 1.2, 1.1	39, 36, 36	37
Kangarooskin.....	A	10	63, 57, 51	2.2, 2.1, 1.9	29, 27, 27	28
	B	10	79, 82, 82	2.1, 2.2, 2.0	38, 37, 41	39
Goatskin, India.....	A	10	68, 62, 54	2.1, 2.0, 1.8	32, 31, 30	31
	B	10	58, 55, 60	1.7, 2.0, 2.0	34, 28, 30	31
Goatskin, garment.....	A	15	46, 40, 26	1.5, 1.2, 0.7	31, 33, 37	34
	B	15	27, 48, 33	0.8, 2.1, 1.4	34, 23, 24	27
Horsehide, garment.....	A	15	23, 17, 18	0.7, 0.6, 0.6	33, 28, 30	30
	B	15	23, 34, 27	0.8, 1.3, 0.9	29, 26, 30	28
Cowhide, chrome glove.....	A	15	35, 19, 19	1.2, 0.8, 1.0	29, 24, 19	24
	B	15	27, 35, 24	1.1, 1.3, 1.1	25, 27, 22	25
Calfskin, chrome.....	A	10	46, 44, 41	1.8, 1.9, 1.7	26, 23, 24	24
	B	10	41, 38, 44	1.6, 1.8, 1.8	26, 21, 24	24
Sheepskin, garment.....	A	10	46, 32, 32	4.0, 3.0, 3.0	12, 11, 11	11
	B	10	12, 6, 15	1.1, 0.7, 1.2	11, 9, 12	11
	B	15	29, 29	3.0, 2.6	10, 11	10

\*Load is recorded as per cent of 3.0 pounds.

Preliminary tests had shown that the scuffing load alone is not a reliable indication of the relative scuff resistance of all types of leather. Side upper leather, which is considered relatively scuff resistant, required only an average scuffing load on the machine, whereas some sheepskin leather required a scuffing load which is considered too high. Examination of scuffed pieces showed that the machine makes a very narrow scuff on side upper leather and a relatively wide scuff, several times the width of the scuffing blade, on sheepskin leather. Since the scuffing load depends upon the width of the scuff, a better indication of the scuff resistance of different types of leather may be obtained by comparing the scuffing loads per unit width of scuff.

Table III shows the results of an experiment in which a series of leathers were compared on this basis. In addition to the scuffing load, the maximum width of each scuff was determined. The load divided by the width is tabulated. On the basis of load per unit width, side upper leather is rated best, and sheepskin is rated much less resistant than the other leathers. Chrome calfskin and horsehide garment leathers also appear to be rated nearer their accepted order on this basis than on a basis of scuffing load.

The experiments reported thus far have involved only a few test pieces from unspecified positions. Further data on the variation in measurements at different locations on a side are needed in order to estimate the significance of differences between leathers. In an experiment undertaken to measure this variation, specimens were cut from a side of chrome calf leather, as shown in Figure 3. Each piece was scuffed in the four directions parallel and perpendicular to the backbone. In this test, each scuffing load is the average of at least three measurements.

TABLE IV

SCUFF RESISTANCE OF CHROME TANNED CALFSKIN AT DIFFERENT LOCATIONS AND IN DIFFERENT DIRECTIONS

Sampling Position†	—Load Required to Produce Scuff* at 0.010 inch Depth—				
	Scuffed toward the				Average
	Backbone	Belly	Head	Tail	
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
1	46	38	30	51	41
2	44	44	35	67	48
3	51	59	61	31	50
4	53	36	24	50	41
5	46	38	35	52	43
6	59	42	62	23	46
7	41	42	28	43	38
8	46	36	26	38	36
9	54	26	53	30	41

\*Load is recorded as per cent of 3.0 pounds. Each scuffing load is the average of at least three measurements.

†See Figure 3.

The results, in Table IV, show that the averages of measurements at different locations vary less than measurements in different directions at the same location. The scuff resistance is somewhat greater in the direction toward the backbone than in other directions. For convenience, tests on each piece might be limited to scuffs in two opposite directions. These data show that results at different positions are less variable if the pieces are scuffed perpendicular to the backbone line than if they are scuffed parallel to it.

Although tests thus far conducted have been limited to light leathers, by suitable modification of the clamping device the apparatus may be used for scuffing heavy leathers.

#### *Summary*

A new apparatus for measuring the resistance of leather to scuffing is described and compared with another machine designed for measuring this property. Application of the new scuff tester is demonstrated by determining the effect of a finishing operation upon scuff resistance.

Measurements at different locations on a side of calfskin leather showed that the resistance to scuffing depends more upon the direction of the scuff than upon the location on the skin.

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